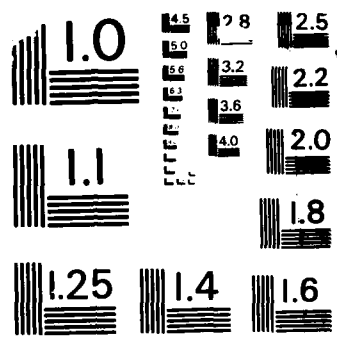


AD-A181 167 STRENGTH AND STRUCTURE OF GA(1-X)IN(X)AS ALLOYS(U) OHIO 1/1
STATE UNIV RESEARCH FOUNDATION COLUMBUS
K T FABER ET AL 15 APR 87 AFOSR-TR-87-0735
UNCLASSIFIED F49620-85-C-0129 F/G 7/2 NL





MICROCOPY RESOLUTION TEST CHART
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DOCUMENTATION PAGE

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| 19. ABSTRACT (Continue on reverse if necessary and identify by block number) Substantial solid solution strengthening of GaAs by In acting as InAs units has recently been predicted for an intermediate temperature, plateau region. This strengthening could account, in part, for the reduction of dislocation density in GaAs single crystals grown from the melt. High temperature deformation measurements have been carried out on GaAs and Ga _{0.99} In _{0.01} As from 700 to 1100°C in the [123] orientation. In this single slip orientation, the critical resolved shear stress of the In-doped material is nearly twice that of the undoped material. Values of the critical resolved shear stress are weakly dependent on temperature, consistent with the solid solution hardening model. The observed increase in resistance to glide is sufficient to eliminate dislocations in large diameter crystals during growth. Electron microscopy is used to relate the mechanical properties of these materials to their dislocated structures. | | | |
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RF Project 764977/717636
Quarterly Report

AFOSR-TM- 87-0735

STRENGTH AND STRUCTURE of $Ga_{1-x}In_x$ AS ALLOYS

K. T. Faber
Department of Ceramic Engineering
J. P. Hirth
Department of Metallurgical Engineering

Approved for public release:

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Chief, Technical Information Division

For the Period
January 1, 1987 - March 31, 1987

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Contract No. F49620-85-C-0129

April 1987



**The Ohio State University
Research Foundation**

1314 Kinnear Road
Columbus, Ohio 43212

The strengthening effect of gallium arsenide by indium additions is under examination. Interpretation of high temperature hardness results of In-free and In-containing GaAs suggests that the intermediate temperature hardening of these materials may be sufficient to reduce dislocation densities by two orders of magnitude during growth. The second quarterly report describes the most recent mechanical tests and electron microscopy in this study to better understand the solid-solution strengthening in these systems.

(1) Progress

Compression tests on LEC grown semi-insulating undoped and In-doped GaAs single crystals have been completed in the [123] orientation in the temperature range 700 to 1100°C. The [123] orientation allows deformation via a single slip system. The In-doped materials had an In concentration of $2 \times 10^{20} \text{ cm}^{-3}$. For both materials, the linear region of the stress-strain curve results in a lower-than-anticipated elastic modulus, indicating the occurrence of micro-creep. The slope is significantly smaller for undoped materials, suggesting a higher creep resistance for In-doped materials.

Both undoped and In-doped materials showed the presence of an easy glide region in this single slip orientation. However, the critical resolved shear stress (CRSS) for the In-doped material was nearly twice that of the undoped material. This observed increase in the resistance to glide is sufficient to eliminate dislocations in the growth of large diameter crystals. Values of the CRSS are weakly temperature

dependent, consistent with the solid solution strengthening model proposed.

In Stage III of the deformation, higher stress values for the onset of dynamic recovery show that dislocation climb is slowed by the Indium doping.

Transmission electron microscopy studies of deformed Indoped and undoped [100] GaAs are complete. Specimens deformed at 900 and 1100°C show complex defect structures due to multiple slip. Perfect as well as partial dislocations forming dislocation networks have been observed. However, dislocation loops, prevalent in specimens deformed at 700°C, were rare in the 1100°C samples. A detailed analysis of the dislocation structures and their interaction mechanism is in progress. An estimate of the stacking fault energy will be performed on these specimens by measuring the width of the partial dislocations in the deformed specimens. Furthermore, TEM studies of deformed materials in the single slip orientation, [123], will be performed.

- (2) Special equipment purchased or constructed

None.

- (3) Changes in key personnel

None.

- (4) Substantive information derived from meetings

Materials for study are continuing to be supplied by Dr. Noel Thomas of Westinghouse R&D Center. Discussions with Dr. Thomas' group take place on a bimonthly basis.

Undoped GaAs grown by the Bridgman technique has been

ordered from Crystal Specialties, Inc. for comparative studies. In addition, Dr. Arati Prabhakar from DARPA has requested high purity Bridgman crystals from Bell Laboratories for our studies.

(5) Problems of concern

None.

(6) Fiscal Status

- (a) Amount currently provided for contract: \$289,268.00
- (b) Expenditures and commitments to 12/31/86: \$165,387.28
March financial statement attached.
- (c) Amount needed to complete work: \$123,880.72
- (d) Estimated date of completion: 8/31/87

DEPT PRINCIPAL INVESTIGATOR(S)
 3420 KATHERINE T FABER
 JOHN P WIRTH

THE OHIO STATE UNIVERSITY RESEARCH FOUNDATION
 PROJECT FINANCIAL SUMMARY
 FOR MONTH ENDING MAR 31, 87

START DATE
 9/01/85

END DATE
 8/31/87

PROJECT
 717636

AF OFC SCI RES
 F49620-85-C-0129

MASTER PROJECT
 764977

| ***** SPONSOR SUPPORT COSTS ***** | BUDGET | EXPENDITURES THIS MONTH | EXPENDITURES TO DATE | COMMITMENTS | UNENCUMBERED BALANCE |
|-----------------------------------|------------|----------------------------|-------------------------|-------------|-------------------------|
| SALARIES AND WAGES - RELEASE TIME | 27,868.00 | 2,358.40 | 17,297.56 | 3,537.60 | 7,032.84 |
| SALARIES AND WAGES - ROTARY TIME | 108,942.00 | 4,510.00 | 63,276.74 | 13,530.00 | 32,135.26 |
| FRINGES - RELEASE TIME | 4,882.00 | 406.82 | 3,082.58 | 495.26 | 1,304.16 |
| FRINGES - ROTARY TIME | 24,707.00 | 678.90 | 9,373.25 | 1,854.97 | 13,478.78 |
| TOTAL PERSONNEL COSTS | 166,399.00 | 7,954.12 | 93,030.13 | 19,417.83 | 53,951.04 |
| REPORTS, REPRU, REPRINTS | | | 418.80 | | 418.80- |
| PURCHASED SERVICES | 1,000.00 | 371.40 | 5,509.86 | 1,383.40 | 5,893.26- |
| SUBCONTRACTS | 4,000.00 | | | | 4,000.00 |
| MATERIALS AND SUPPLIES | 19,595.00 | 457.91 | 6,966.40 | 860.00 | 11,758.60 |
| OTHER DIRECT COSTS | 415.00 | 27.54 | 785.05 | | 370.05- |
| EQUIPMENT PURCHASE | 7,885.00 | | 7,937.22 | | 52.22- |
| TRAVEL - DOMESTIC | 4,000.00 | | 2,824.75 | | 1,175.25 |
| TOTAL DIRECT COSTS | 203,294.00 | 8,810.97 | 117,472.21 | 21,661.23 | 64,150.56 |
| INDIRECT COSTS | 85,984.00 | 3,788.72 | 47,915.07 | 9,314.33 | 28,754.60 |
| TOTAL SPONSOR SUPPORT COSTS | 289,278.00 | 12,599.69 | 165,387.28 | 30,975.56 | 92,905.16 |

| ACCOUNT REC NO | AMOUNT PERCENTAGE | OSU COST SHARING GUARANTEED | TO DATE | SPONSOR + OSU EXPEND TO DATE | IND COST RATES | DEV OFFICER |
|-------------------|----------------------|--------------------------------|---------|---------------------------------|----------------|-------------------------|
| 060006 | 5 | | | 165,387.28 | G 44 43.00 .00 | WOUDY |
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